PATENT SPECIFICATION

DRAWINGS ATTACHED

897,384

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COMPLETE SPECIFICATION

Improvements in or relating to apparatus for Raising and Lowering a Member by Compressible Fluid

We, HYDRO - CHEMIE AKTIENGESELLSCHAFT, a Joint Stock Company organised under the laws of Switzerland, of 21, Dreikönigstrasse, Zurich, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to apparatus for raising and lowering a member, e.g. a predrawing plug in a moulding machine, by means of a double-acting piston displaceable in a cylinder by compressible fluid under pressure, e.g. compressed air or steam.

It may be desirable in some cases to provide such an apparatus with a device for retaining said member in raised or top stroke position against the effect of gravity, in such a way it can both be quickly lowered from that position and arrested at the end of its downward stroke without interruption by abutment of the member itself or part coupled therewith against any obstacle in its path, by which said stroke would otherwise be limited.

However, if the member were held thus raised by pressure of the fluid within the working space bounded by one side of the piston, and then lowered by releasing that pressure and simultaneously introducing the fluid into the working space on the opposite side of the piston, this would lead to one of the following drawbacks. The fluid would either escape from the first mentioned working space so slowly that the downward stroke of the member would be substantially delayed, or so quickly as not to be under sufficiently high pressure at the end of that stroke to stop the member against the influence both of its weight and of the pressure of the fluid in the second-mentioned working space, before any abutment of the kind mentioned can take place.

In apparatus of the kind mentioned according to the present invention, having a device for independently retaining the member in its raised position when the piston is free from fluid pressure, said retaining device therefore comprises a swingable member movable through a range of angular positions limited at one end by a fixed abutment and a spring which exerts a turning moment adapted, when said swingable member is in the end part of said range adjacent said abutment, to rotate it towards the latter but to rotate it oppositely over the remainder of the range, the arrangement being also such that, when the swingable member is in contact with the abutment, it projects into the path of an element movable with said member so as to be engaged, during the raising of that member, by said element and to be carried thereby into said remainder of the range.

In one form of such retaining device the swingable member may carry a roller or like coupling part and the element may have a groove extending transversely from a flared recess, said coupling part and recess being so arranged that, when said member is in contact with the abutment, the coupling part lies in the path of this recess so as to become engaged by the latter and then transferred into said groove, as said element advances. In an alternative form of the device the swingable member consists of a toothed segment and the element has at least one tooth which engages the teeth of said segment as said member approaches its raised position and leaves such engagement during the lowering of that member.

Two embodiments of the invention applied to an apparatus for moulding foils of synthetic resin in which the retaining device takes these alternative forms respectively are shown by way of example in the accompanying drawings, whereof:—

Figure 1 is a schematic representation of the first such embodiment;

Figures 2 to 7 are diagrams of part of Figure 1, in six different working positions;

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Figures 8 to 10 show the retaining device of this first embodiment in three positions corresponding to different stages of the working cycle of the apparatus, and

Figures 11 to 13 show the retaining device of the second embodiment in three similar positions.

The apparatus thus illustrated has an upwardly open moulding box 1, the rim of which has a surface 2 for supporting the synthetic resin foil 3 to be moulded. A frame 4 which is swingably secured to this box by means of a hinge (not shown) and can be drawn towards said box on the side opposite said hinge by means of a locking device (also not shown), is used to press said foil tightly onto said supporting surface over the whole peripheral extent thereof. Within the moulding box 1 is disposed a mould 5 with a moulding recess 6 of the same shape as the outside of the finished article to be produced from the foil 3, e.g. a dish. The mould 5 also has an upper supporting surface 7 for the foil 3, and ducts 8 connecting the moulding recess 6 to the space surrounding the mould in the box 1, which can be evacuated through a conduit 9.

A pre-drawing plug 10 which forms part of this vacuum-moulding apparatus is movable up and down by actuating means, as described hereinafter, between the position in which it is shown in full lines and that 11 indicated in dash-and-dot lines (Figure 1). The apparatus also comprises a suitable device (not shown) for heating the foil.

Before moulding, the foil 3 is heated to its softening temperature and the plug 10 is then quickly moved down into position 11, so that the plasticized foil 3 is pressed against the supporting surface 7 and is drawn out into the recess until its shape approximates to that of the article to be produced. The plug 10 then comes to a standstill and the moulding box 1 is quickly evacuated through conduit 9, so that the atmospheric pressure, acting on the foil from above, forces it into close contact with the walls of the recess 6 and causes it to leave the bottom of the plug, which is thereupon raised up again into its initial position. After the foil thus moulded has cooled down and solidified, the conduit is shut off from the source of vacuum, the frame 4 is swung up and air of atmospheric or slightly higher pressure is admitted into the moulding box conveniently through the same conduit. The moulded foil can then be removed and a fresh foil can be clamped in position on the box.

To prevent uncontrolled creeping of the foil 3 during its pre-drawing by the plug 10, the downward movement of the latter preferably takes place very quickly. Moreover said plug should be stopped as accurately as possible in the position 11, and that position should be such that the foil, in being predrawn thereby, is brought close to the bottom of the mould without however coming into actual contact with it.

The plug 10, which is mounted on a piston rod 12, is moved in the required manner by means of compressed air admitted to a cylinder 13 in which a double-acting piston 14 carrying said rod is displaceable. This piston separates an upper working space 15 of the cylinder from a lower working space 16 thereof and these spaces can each be connected at will by means of a three-way cock 17, 18 either with a compressed-air conduit 19 or with an outlet 20, 21 to the atmosphere or shut off from both in an intermediate position of said cock.

The apparatus so far is well known for plug-assisted vacuum moulding, the present invention being concerned more particularly with means for automatically retaining the piston rod 12 together with the plug 10 and the piston 14 in their initial position, i.e. at the top of their stroke, the mechanism for which purpose, as shown in Figures 8 to 10 and characterizing the first of the aforementioned embodiments of the invention, will next be described.

Beneath the cylinder 13 a horizontal groove 23 is milled into the piston rod 12, a roller 25 on a swingable lever 24 fitting slidably into said groove and said lever being mounted on a stationary pivot 27 of a frame 26 whereby said cylinder is supported. A tension spring 28 is hooked at one end to a pin 29 on this lever and at its opposite end to a pin 30 of said frame, this pin 30 being so disposed in relation to the pivot 27 that said spring tends to rock the lever clockwise (Figures 1 and 8) when the piston rod is raised and the lever 24 is in its corresponding angular position as determined by the engagement of the roller 25 in the groove 23. However, when the piston rod moves down together with said roller, it swings the lever 24 and pin 29 below the dead centre line through pivot 27 and pin 30 so that the spring 28 now tends instead to rotate the lever anti-clockwise (Figure 9). The groove 23 is continued by a vertical recess 32 which is also milled into the piston rod and flares upwardly to its mouth in such a way that, as said rod descends, the lever 24 will have reached a fixed abutment 31 on the frame 26, before the roller 25 leaves said recess and that, as the rod rises again, said roller will become re-engaged by the recess, provided the lever is then still in contact with said abutment. Moreover the recess 32 is so shaped and disposed relatively to groove 23 that the roller 25 is pushed into the groove 23 during this upward movement without the lever and piston rod becoming interlocked.

The spring 28 is strong enough to ensure that the clockwise turning moment exerted thereby on the lever 24 in the top position of the piston rod 12 is greater than the opposite turning moment which is then exerted on the

lever 24 through the roller 25 by the weight of said rod and of the parts connected thereto. In order to keep down the latter moment and the force needing to be applied by the spring 28, it is desirable to arrange and dimension the parts so that the straight line through roller 25 and pivot 27 in their Figure 8 position does not subtend too great an angle with the vertical. At the same time this angle should be big enough for the lever 24 not to interlock with the piston rod 12 so as to impede its downward movement.

The apparatus in accordance with the foregoing description works as follows:

At the start (Figure 1), the piston rod 12, piston 14 and plug 10 are retained at the top of their stroke by the spring 28, acting through the lever 24 and the engagement of roller 25 in groove 23, the two cocks 17 and 18 being then set so that the working spaces 15 and 16 are both connected with the atmosphere through the outlets 20 and 21 respectively (Figure 2). The foil 3 is then clamped onto the moulding apparatus and heated to its softening temperature. When this has been done, the upper working space 15 is connected to the compressed air conduit 19, in which a pressure of for example 5 kg/cm² is maintained, by turning cock 17, whilst the lower working space 16 remains connected to the atmosphere. The air flowing into the upper working space now forces down the piston together with the piston rod and plug, whilst part of the air in the lower working space escapes without the pressure in the latter rising substantially above that of the atmosphere. The pressure thus acting on the piston brings about rapid acceleration of the said parts downwardly (Figures 3 and 4) causes the foil 3 to be pre-drawn by the plug 10. The lever 24 is thereby swung from its Figure 8 position through that of Figure 9 into that of Figure 10, until after the roller 25 has left the groove 23 for the recess 32 and become disengaged from the latter also, the action of the spring on the piston rod ceases, and the spring merely draws said lever against the abutment 31.

After the piston 14 and its associated parts 10 and 12 have moved through a predetermined fraction, e.g. two-thirds, of their downward stroke, the cocks 17 and 18 are both shut. The compressed air thus enclosed in the upper working space 15 now expands and the air enclosed in the lower working space 16 is correspondingly compressed to a degree which counteracts the pressure in space 15 and consequently reduces the kinetic energy of the moving parts 10, 12, 14 before finally bringing them to rest in the position required, i.e. the position 11 of plug 10 (Figure 1), which can be determined by means of the control mechanism of the two cocks. Thus, at the moment when the plug 10 has sufficiently approached that position or has already reached it, both cocks need to be reversed so that the upper working space 15 now becomes connected with the atmosphere by cock 17 through the outlet 20 and the lower working space 16 to conduit 19 by cock 18. The air which consequently flows from that conduit into the working space 16 then forces the piston 14 upwardly against the gravity force acting on the parts 10, 12 and 14, thereby causing air to be displaced from the upper working space 15 into the atmosphere (Figure 6). Towards the end of this upward stroke the flared mouth of the recess 32 contacts the roller 25 and moves it over into the groove 23, thus lifting the lever 24 off the abutment 31. After having become engaged within said groove, said roller moves up with the piston rod 12, so that the lever 24 is first swung in the sense opposite to that of the turning moment produced by the spring 28 (Figure 9) until the direction of that turning moment changes back due to the return of the pin 29 above the dead centre line through pivot 27 and pin 30, after which the spring assists the further rotation of the lever. When the piston rod 12, together with parts 10 and 14 and lever 24, have returned to their initial position (Figures 1 and 8), cock 18 is reset to connect the lower working space 16 with the atmosphere through outlet 21 (Figure 7). The air pressure in that working space which until now has opposed the weight of the parts 10, 12, 14 thereupon becomes ineffective, but in spite of this said parts are prevented from falling back by the spring 28, acting through lever 24 and roller 25.

The required actuation of the cocks 17 and 18 is preferably effected according to the motion of the piston rod 12 by means of micro-switches and electromagnets, excepting the first actuation of cock 17 by which the upper working space 15 is connected to conduit 19 and the downward motion of parts 10, 12 and 14 is initiated, and which can be effected by hand, by means of a timer switch a predetermined time after the heating device has been switched on, or by a switch responsive to the temperature of the foil 3.

Instead of the cocks 17 and 18, two valves which can be actuated electromagnetically may be used for controlling the connection of the respective working spaces 15 and 16 with conduit 19 and the atmosphere.

In the alternative form of the retaining device shown in Figures 11 to 13 and characterizing the second embodiment of the invention, the lever 24 is replaced by a toothed segment 33 mounted on a pivot 27, the spring 28 acting on this segment in the same way as on lever 24 of Figures 8 to 10 and the angular movement of the segment being limited by an abutment 34 serving the same purpose as abutment 31. The piston rod 12 is here provided with a short rack of teeth 35 which mesh with the teeth 36 of the toothed segment

33 when said rod is at the top end of its stroke (Figure 11). By the downward motion of the rod, the toothed segment is then rocked into a position near the abutment 34, in which the teeth 35 of the rod leave their engagement with the teeth 36 of the segment (Figure 12), whereupon the latter is swung down onto the abutment by the spring 28 (Figure 13). When the piston rod 12 moves upwardly, the uppermost of its teeth 35 first engages the teeth of the segment 33 (Figure 12) and swings the latter away from the abutment 34, after which the remaining teeth 35 of the rod successively engage the teeth of the segment while returning the latter to its initial position (Figure 11). The spring 28 exerts on the segment a turning moment which is opposed to that due to the weight of the parts 10, 12 and 14 and holds these parts lifted, just as in the other embodiment.

Of the teeth 35, only the uppermost is strictly necessary, the remainder serving merely to distribute the load in the top position of the piston rod in which the whole weight of the parts 10, 12 and 14 is borne by the segment. The turning moment produced by that weight and acting on the segment can be reduced by keeping down the radius of the pitch circle of the teeth 36. In order to ensure nevertheless an effective distance between pin 29 and the pivot 27 of the toothed segment 33 in view of the turning moment to be exerted on that segment by the spring 28, said pin can be carried by a separate lever on the pivot 27 laterally of the toothed segment 33 and rigidly connected thereto.

The pre-drawing plug 10 need not be fixed to the piston rod 12 itself, but can alternatively be connected to said rod by means of a suitable linkage or gearing, in which case the axis of the cylinder 13, of the piston 14 and of the rod 12 could for example be horizontal, so that the weight requiring to be supported by the retaining device would be diminished by that of said piston and rod.

WHAT WE CLAIM IS:—

1. Apparatus for raising and lowering a member (10), by means of a double-acting piston (14) displaceable in a cylinder (13) by compressible fluid under pressure and having a device for independently retaining said member in its raised position when said piston is free from any such pressure, wherein said retaining device comprises a swingable member (24 or 33) movable through a range of angular positions limited at one end by a fixed abutment (31 or 34) and a spring (28) which exerts a turning moment adapted, when said swingable member is in the end part of said range adjacent said abutment, to rotate it towards the latter but to rotate it oppositely over the remainder of the range, the arrangement being also such that, when the swingable member is in contact with the abutment, it projects into the path of an element (12) movable with said member (10) so as to be engaged, during the raising of that member, by said element and to be carried thereby into said remainder of the range.

2. Apparatus in accordance with Claim 1, wherein the swingable member carries a roller or like coupling part (25) and the element (12) has a groove (23) extending transversely from a flared recess (32), said coupling part and recess being so arranged that, when said member is in contact with the abutment, the coupling part lies in the path of the recess so as to become engaged by the latter and then transferred into said groove, as said element advances.

3. Apparatus in accordance with Claim 1, wherein the swingable member consists of a toothed segment (33) and the element (12) has at least one tooth (35) which engages the teeth (36) of said segment as said member (10) approaches its raised position and leaves such engagement during the lowering of that member.

4. Apparatus in accordance with any preceding claim, wherein the spring acts on the swingable member at a point (29) thereof in a direction past the axis of rotation (27) of said member on one or the other side according to the position of the latter, and so that the force exerted by said spring on this member has a component directed from said point towards said axis.

5. Apparatus in accordance with any preceding claim, wherein the axis of rotation (27) of the swingable member is so positioned with respect to the path of the element (12) that the force exerted by the weight of the member (10) on said swingable member through said element has a component directed towards said axis when said member (10) is in its raised position.

6. Apparatus for raising and lowering a member by compressible fluid under pressure in any of the forms substantially as hereinbefore described or illustrated in the accompanying drawings.

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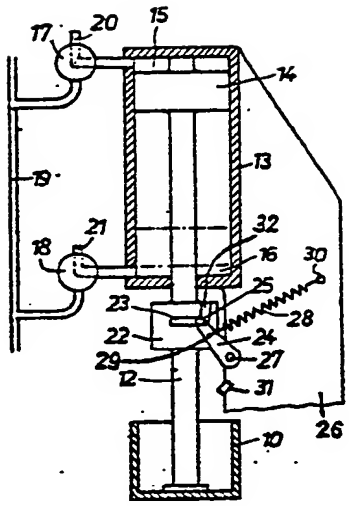


Fig.1

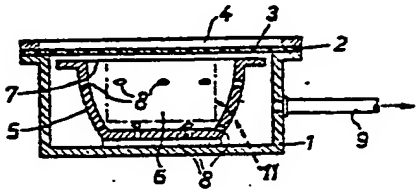
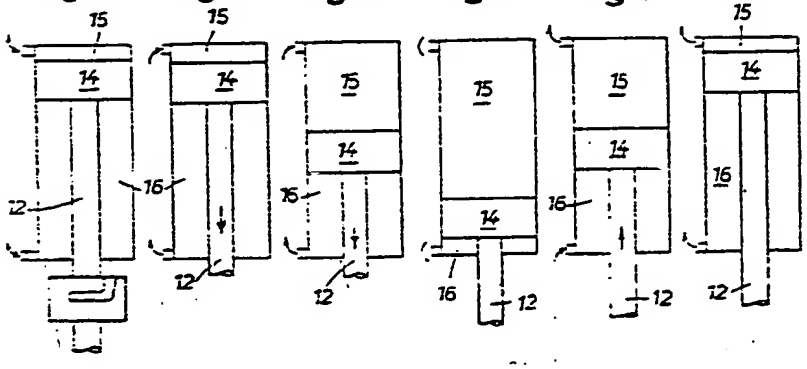


Fig.2 Fig.3 Fig.4 Fig.5 Fig.6 Fig.7



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Sheets 1 & 2

Fig.8

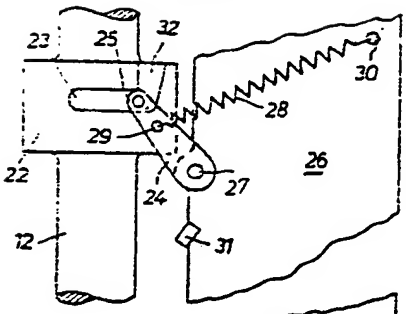
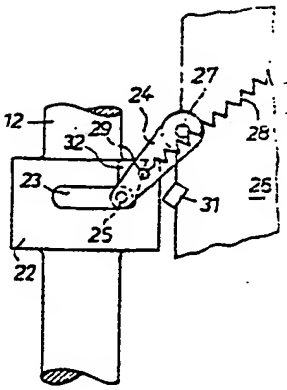


Fig.9



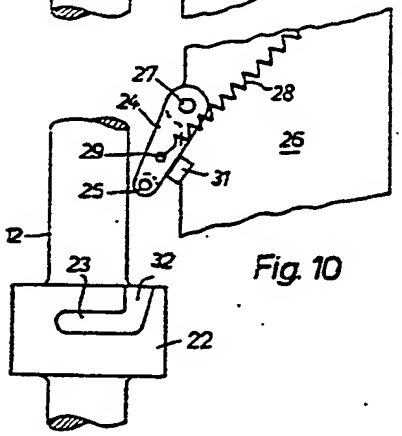


Fig. 10

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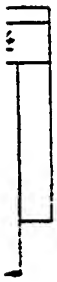

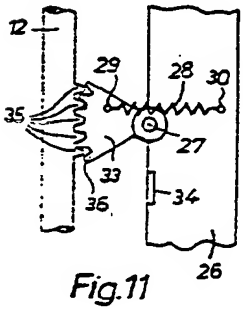

Fig.11

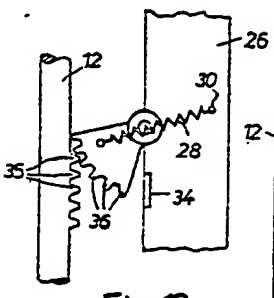

Fig. 12

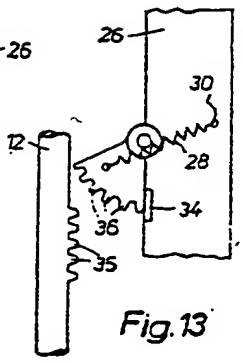

Fig.13

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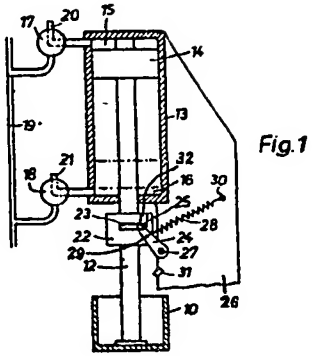
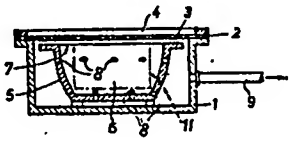


Fig.1



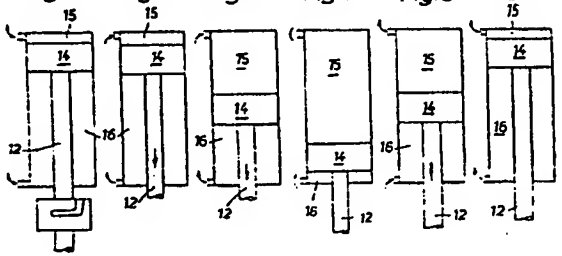


Fig.2 Fig.3 Fig.4 Fig.5 Fig.6 Fig.7

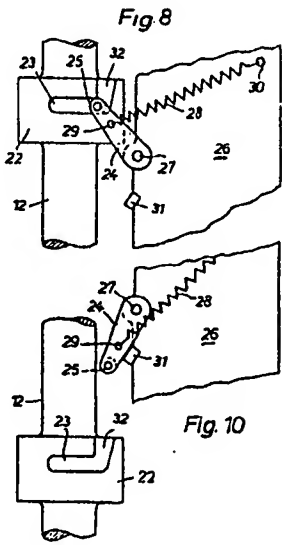


Fig.8

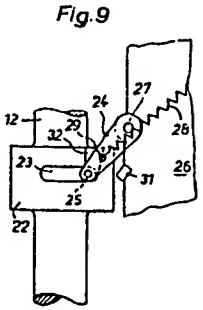


Fig.9

Fig.10

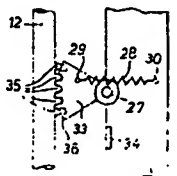


Fig.11

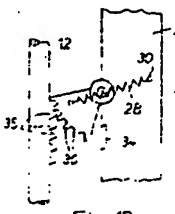


Fig 12

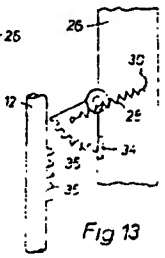


Fig 13